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Kimura

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(45) **Date of Patent: Feb. 23, 2016**

(54) **CONNECTOR**

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H01R 12/00 (2006.01)
H01R 13/41 (2006.01)
H01R 12/71 (2011.01)

(52) **U.S. Cl.**
CPC ***H01R 13/41*** (2013.01); *H01R 12/716* (2013.01)

(58) **Field of Classification Search**
CPC .. H01R 12/57; H01R 12/585; H01R 13/6315; H01R 13/748; H01R 23/725
USPC 439/74, 83, 247, 248, 637, 342, 733.1
See application file for complete search history.

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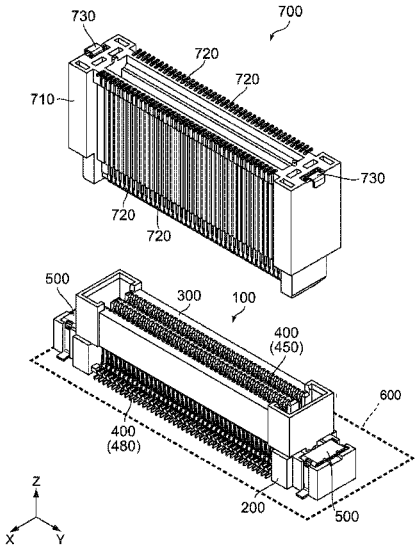
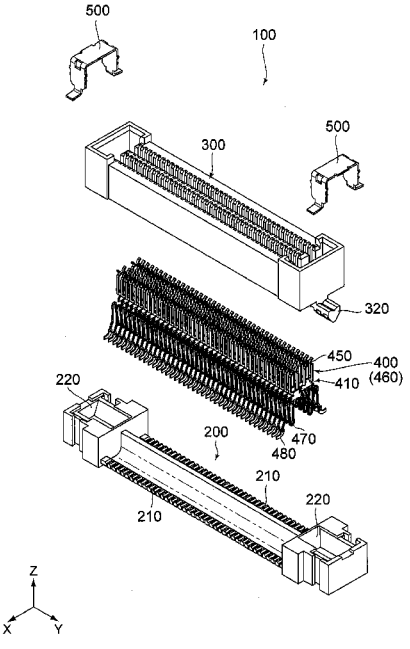
(57) **ABSTRACT**

A connector comprises a housing and a plurality of contacts. Each of the contacts has one or more first sets and one or more second sets. The first set includes two first press-fit portions which protrude oppositely to each other in a first direction. The second set includes two second press-fit portions which protrude oppositely to each other in a second direction perpendicular to the first direction. The first press-fit portions and the second press-fit portions are press-fit in the housing.

4 Claims, 8 Drawing Sheets





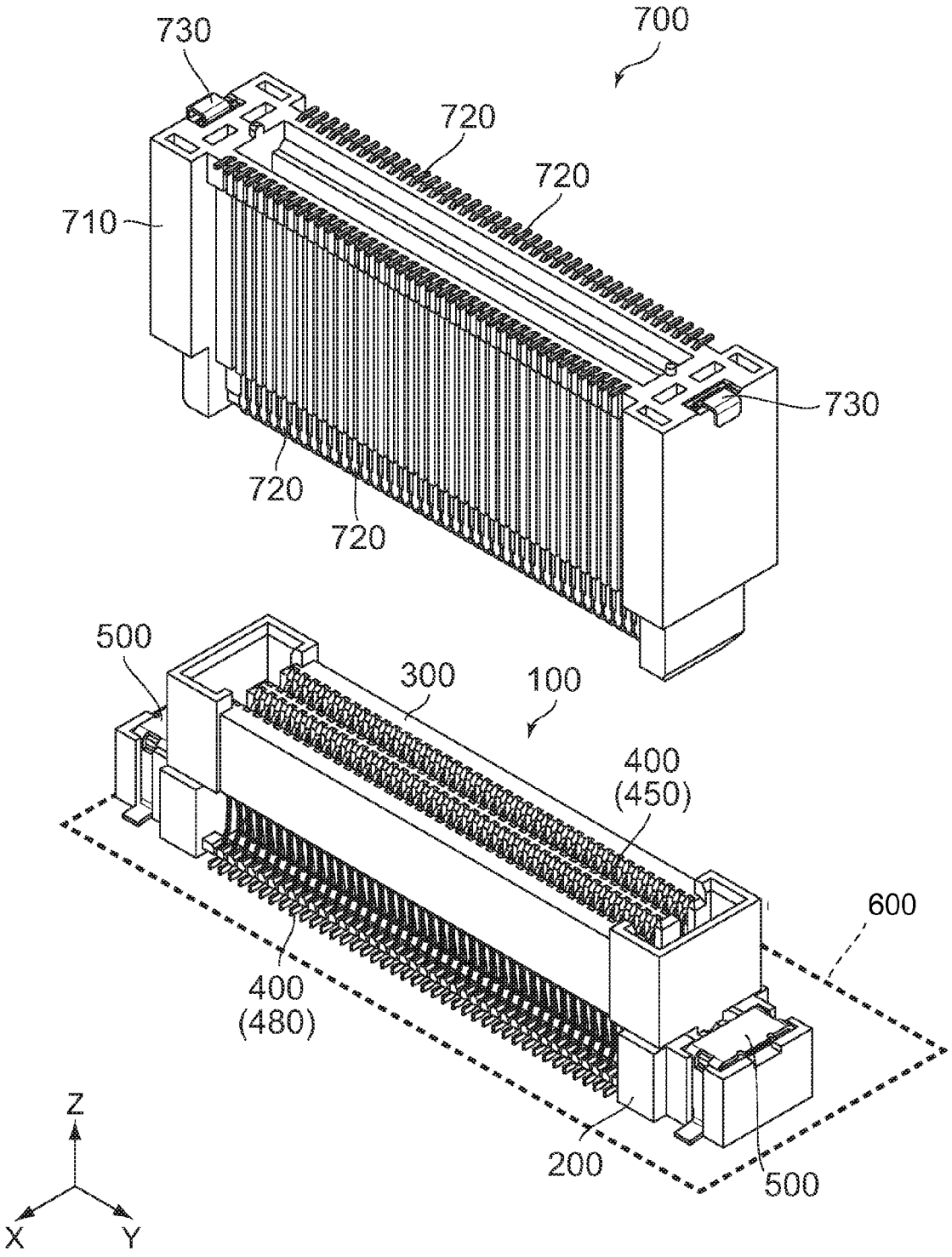
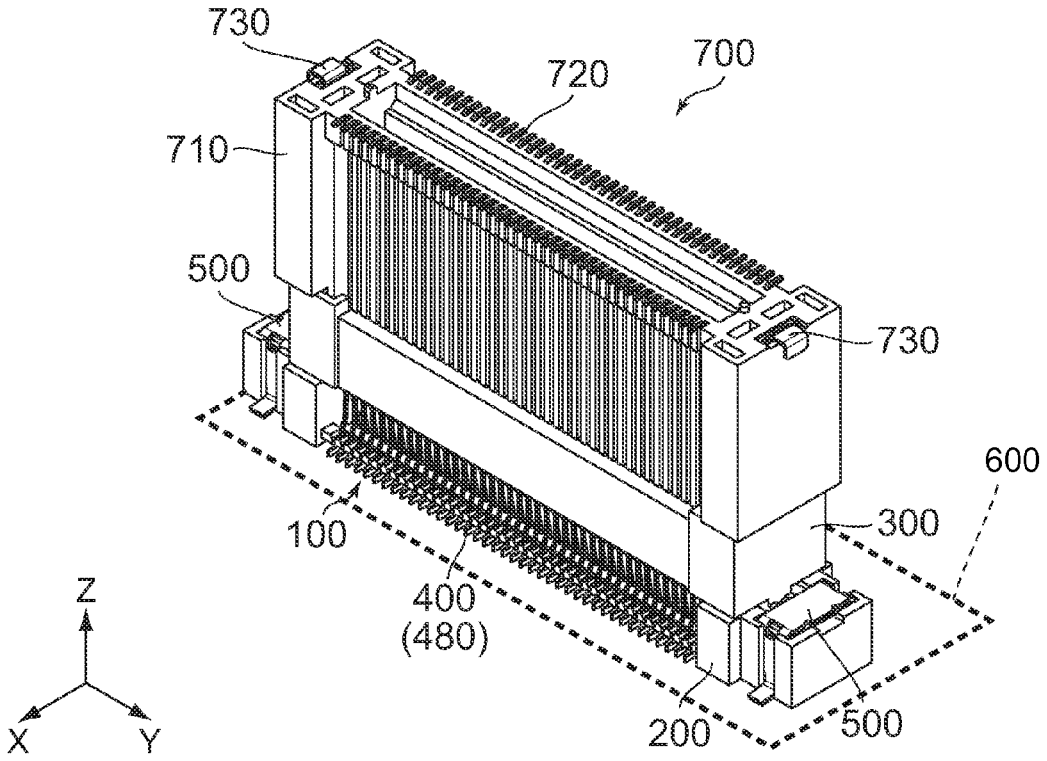

730
700
720
720
710
730
720
720
500
300
100
400
(450)
600
400
(480)
200
500
Z
X
Y

FIG. 1


730
720
700
710
500
730
600
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100
400
(480)
200
500
Z
X
Y

FIG. 2

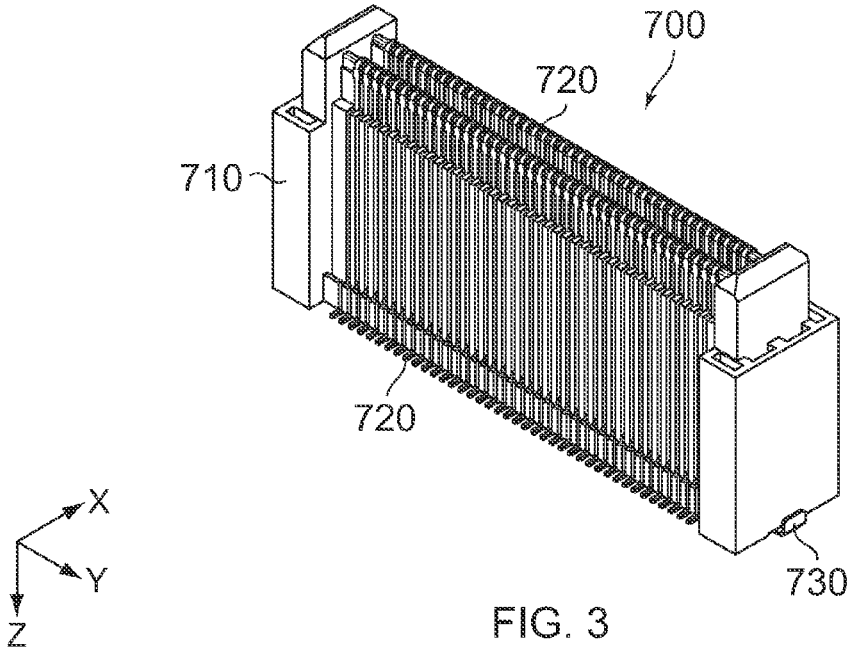
700
720
710
720
730
X
Y
Z

FIG. 3

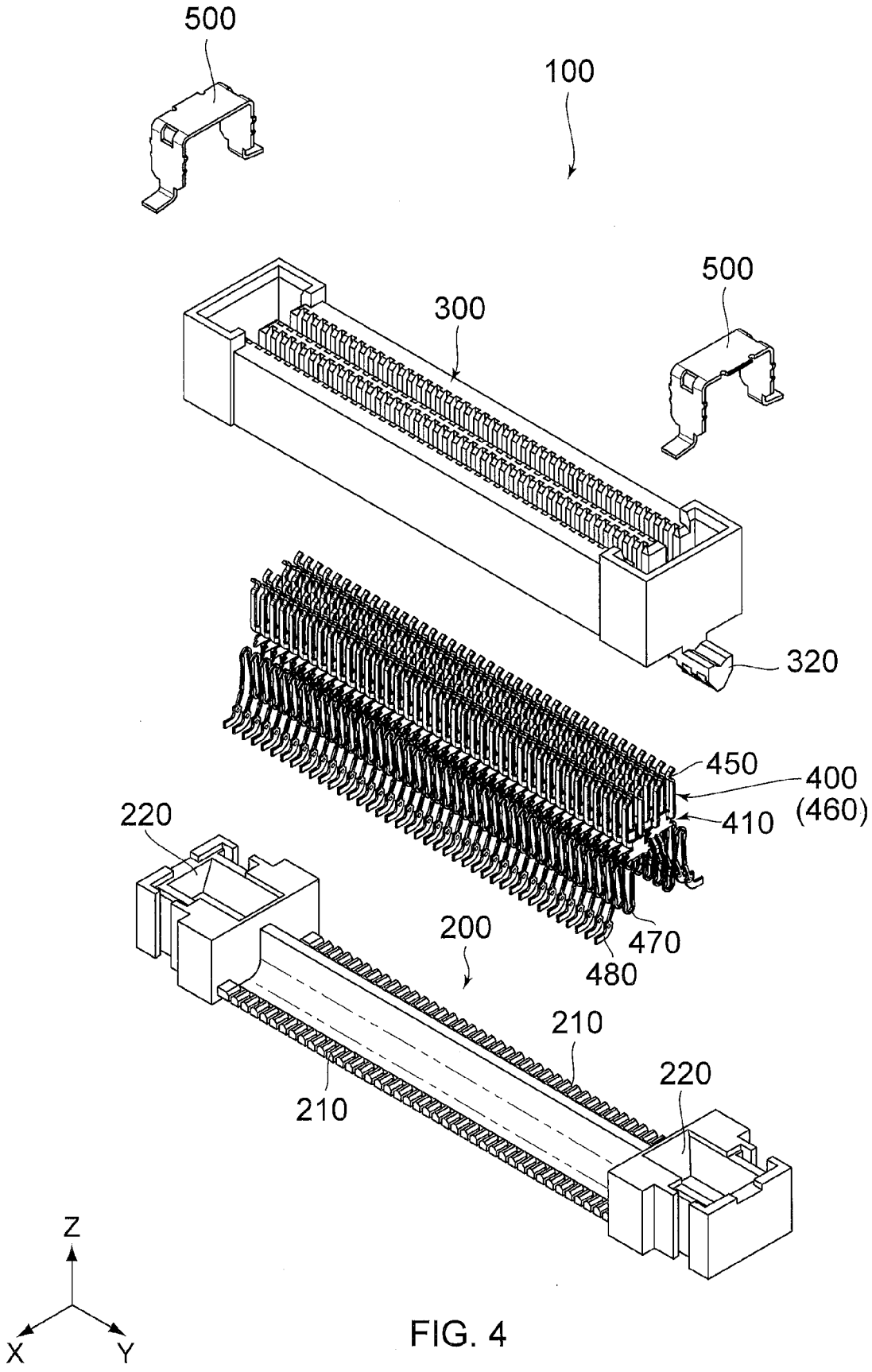
500
100
500
300
320
450
400
(460)
410
220
200
470
480
210
220
210
Z
X
Y

FIG. 4

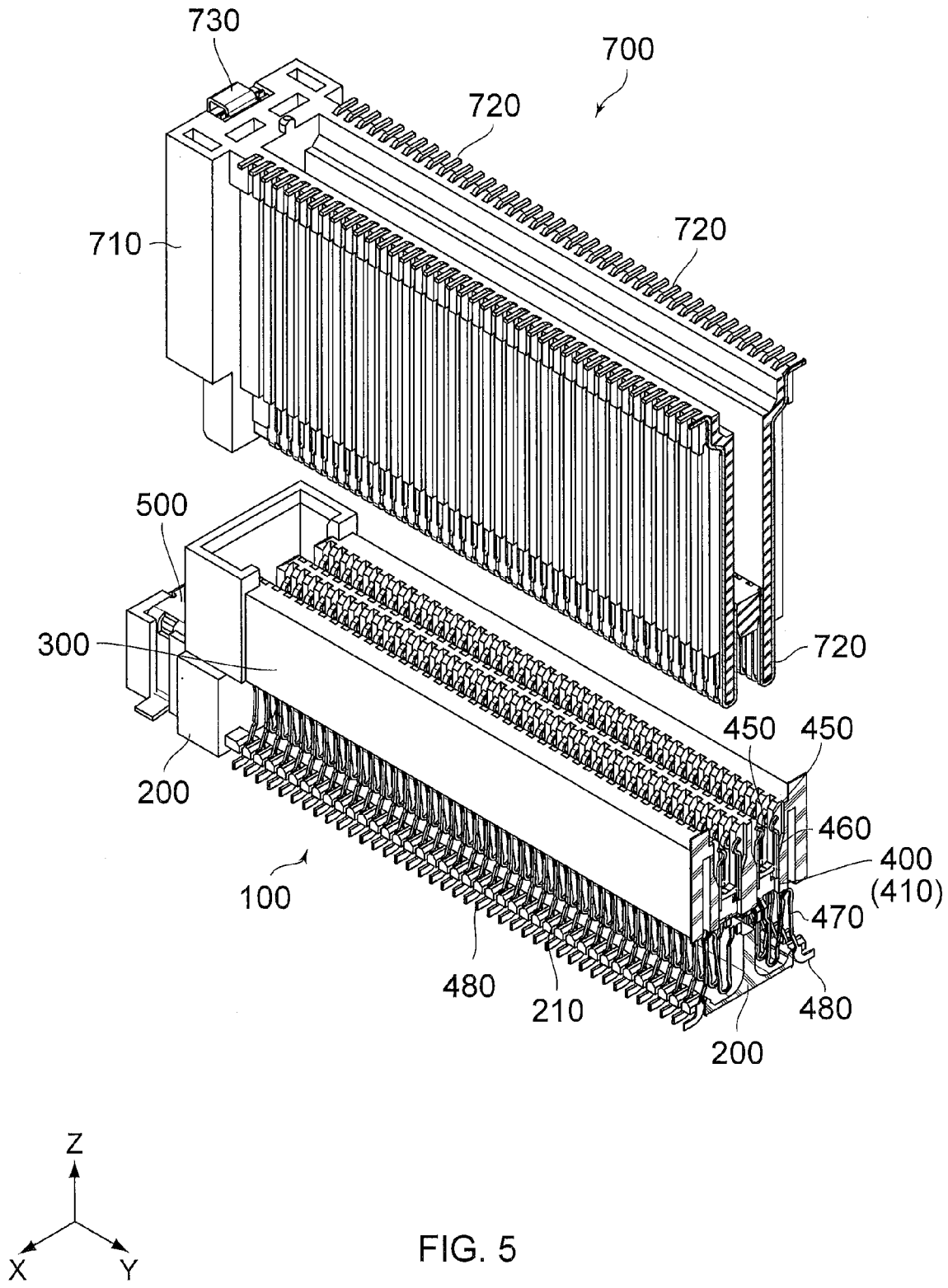
730
700
720
710
720
500
300
720
450
450
200
460
400
(410)
100
470
480
210
480
200
Z
X
Y

FIG. 5

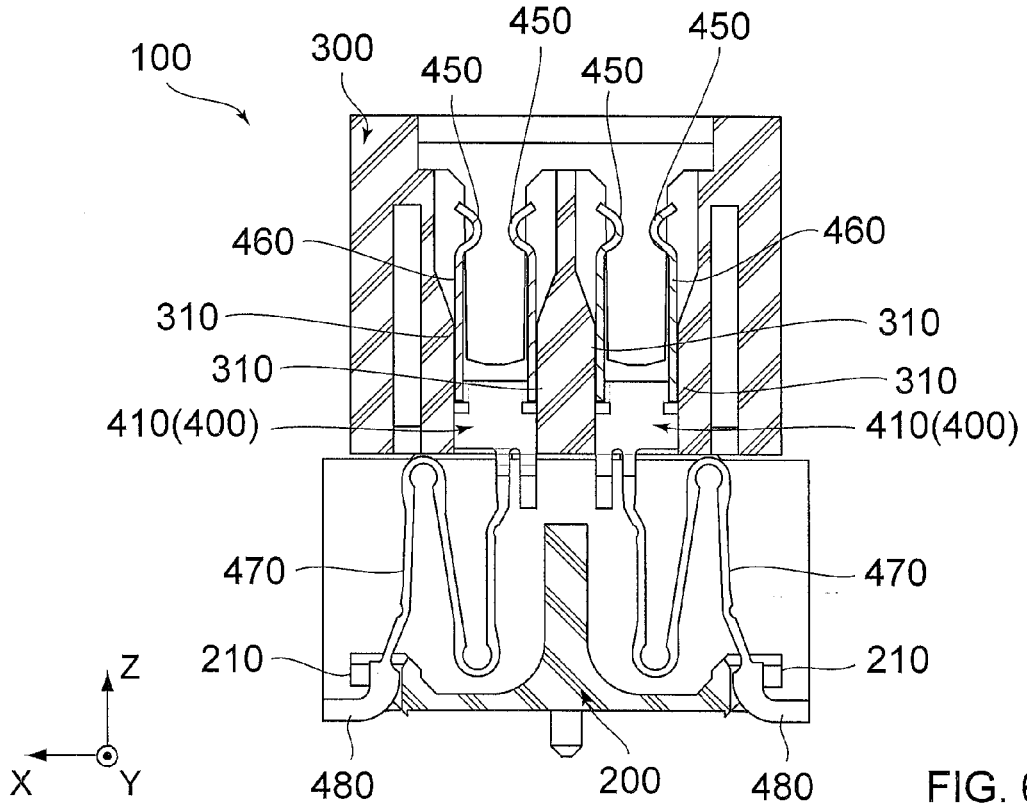
100
300
450
450
450
450
460
460
310
310
310
310
410(400)
410(400)
470
470
210
210
480
200
480
Z
X
Y

FIG. 6

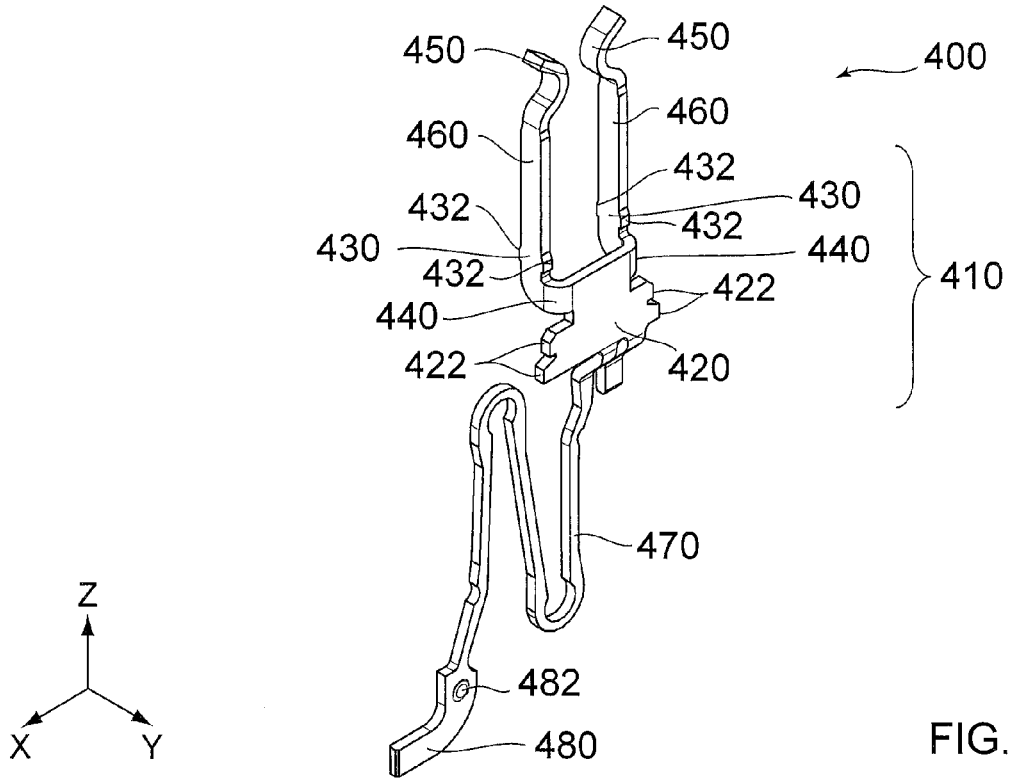
450
450
400
460
460
432
432
430
430
432
440
432
422
440
422
420
410
470
482
480
Z
X
Y

FIG. 7

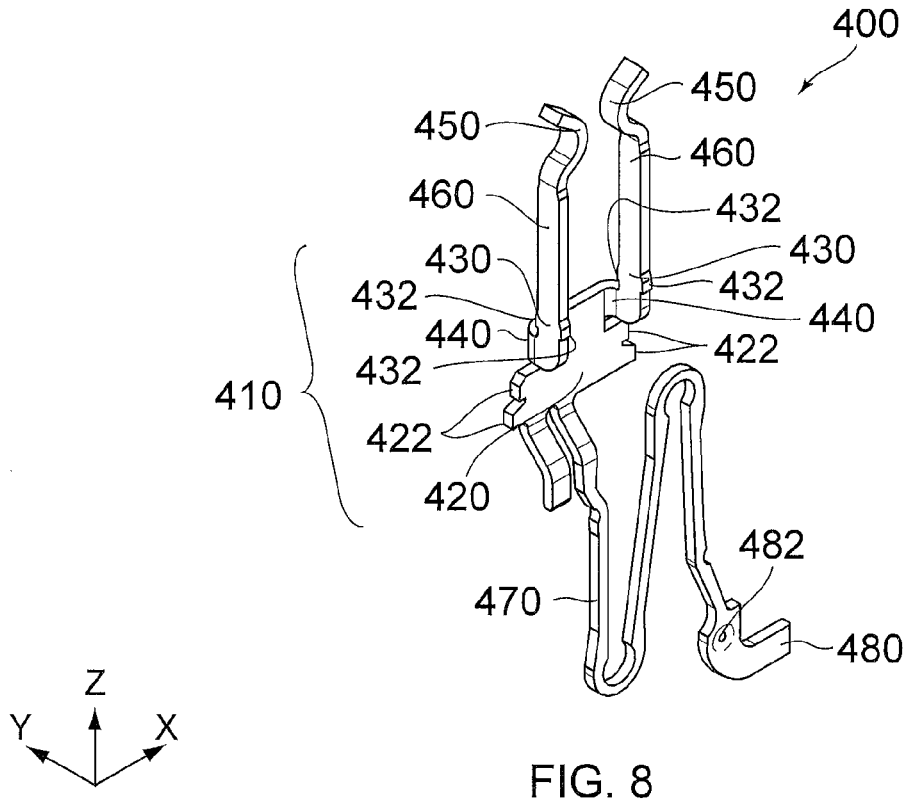
400
450
450
460
460
432
430
430
432
432
440
440
422
410
432
422
420
482
470
480
Z
Y
X

FIG. 8

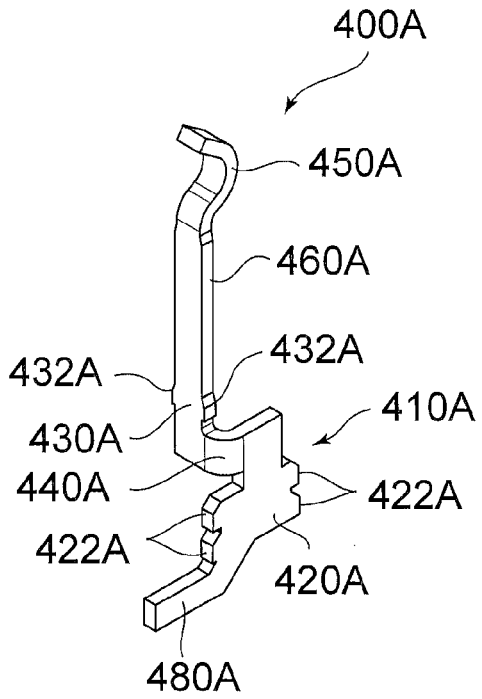
400A
450A
460A
432A
432A
410A
430A
440A
422A
422A
420A
480A

FIG. 9

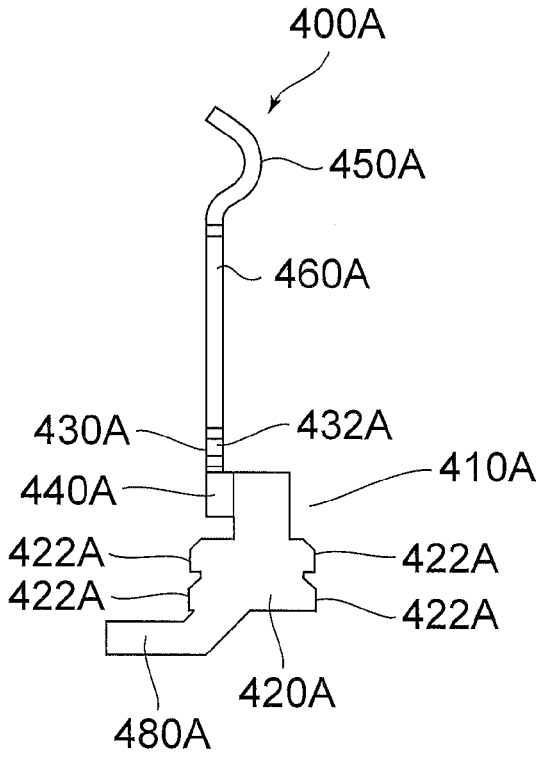
400A
450A
460A
430A
432A
410A
440A
422A
422A
422A
422A
420A
480A

FIG. 10

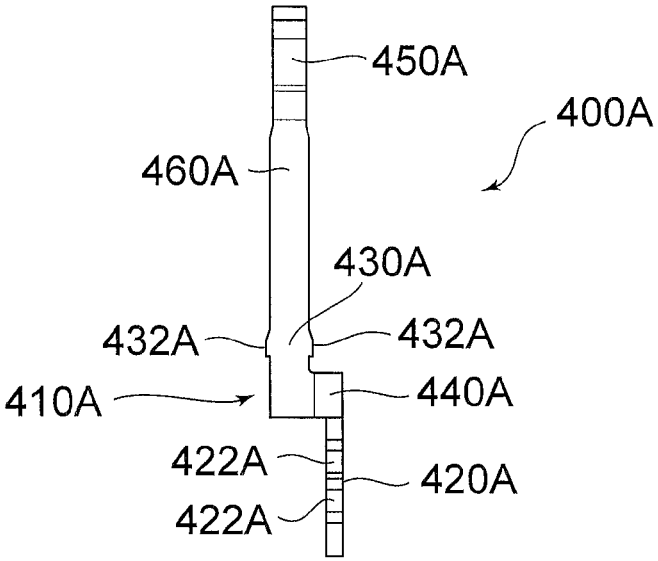
450A
400A
460A
430A
432A
432A
410A
440A
422A
420A
422A

FIG. 11

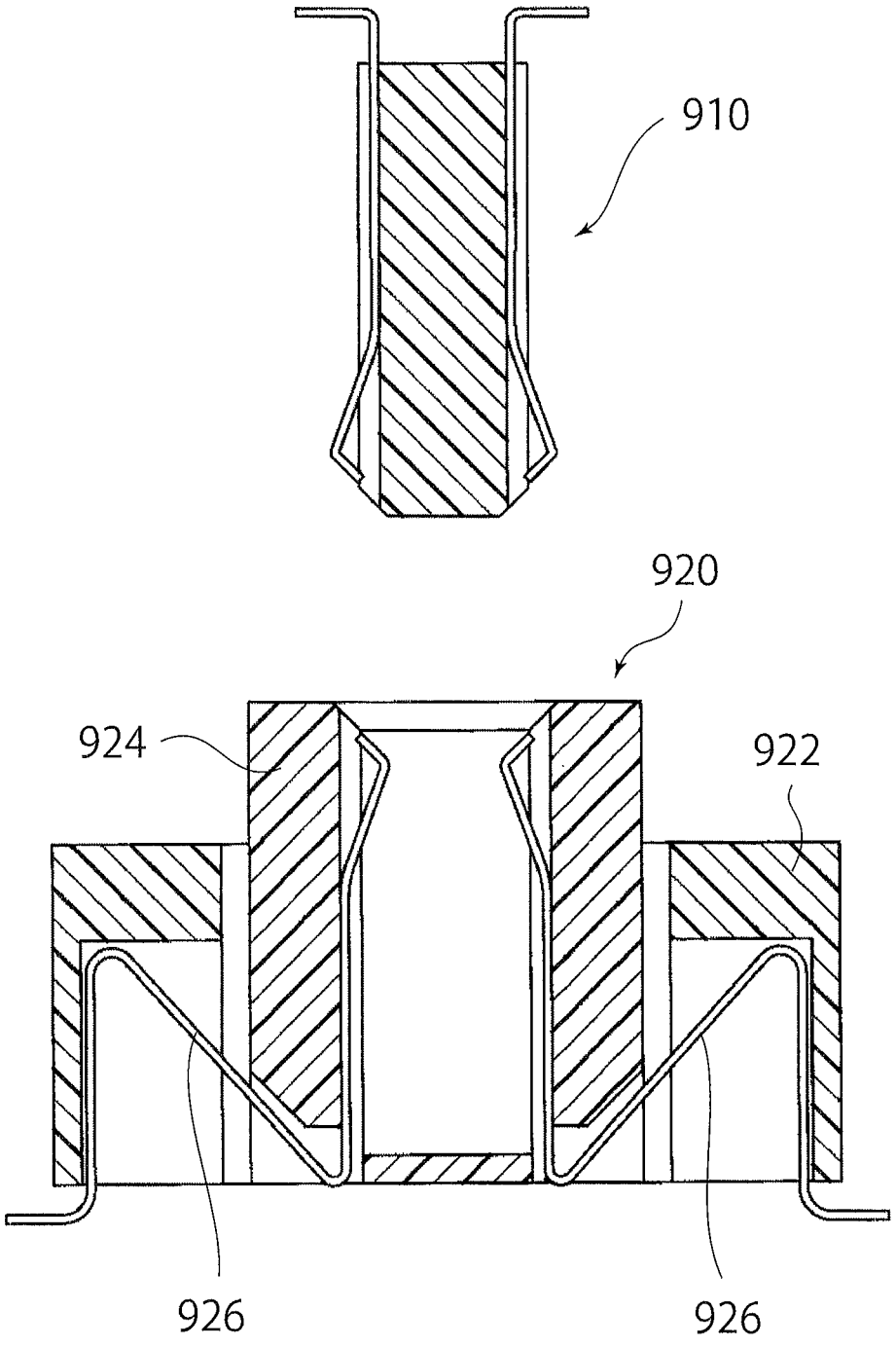

FIG. 12
PRIOR ART

CONNECTOR

CROSS REFERENCE TO RELATED APPLICATIONS

An applicant claims priority under 35 U.S.C. §119 of Japanese Patent Application No. JP2013-164567 filed Aug. 7, 2013.

BACKGROUND OF THE INVENTION

This invention relates to a connector comprising a contact and a housing and, in particular, to a connector where the contact is press-fit in the housing.

For example, this type of connector is disclosed in the second embodiment shown in FIGS. 5 to 10 of JP-A 2010-272320 (Patent Document 1), the content of which is incorporated herein by reference.

As shown in FIG. **12**, Patent Document 1 discloses a first connector **910** (mating connector) and a second connector **920** (connector) having so-called floating structure. The second connector **920** comprises a stationary housing **922**, a movable housing **924** and a plurality of contacts **926**. The movable housing **924** is supported by the contacts **926** so as to be movable, relative to the stationary housing **922**, in a plane perpendicular to a mating direction.

In general, in a connector with floating structure, when its movable housing is moved in an orthogonal plane perpendicular to a mating direction, various stresses directed in various directions on this orthogonal plane are applied to its contact. Accordingly, supporting position at which the contact supports the movable housing might be shifted. In even worse cases, the contact might come off the supporting position.

Even in a connector not having floating structure, a problem might be caused when stresses are similarly applied to its contact held by a housing. For example, when the aforementioned stresses are applied to the contact under a case where the connector is mounted on a circuit board and where an SMT portion of the contact is fixed to the circuit board by using solder, the stresses might make the contact be loosely held by the housing. As a result, the contact might be moved so that the solder, which fixes the SMT portion to the circuit board, might be cracked.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a connector which can keep relation between a housing and a contact even if various stresses directed in various directions are applied to the contact.

One aspect of the present invention provides a connector comprising a housing and a plurality of contacts. Each of the contacts has one or more first sets and one or more second sets. The first set includes two first press-fit portions which protrude oppositely to each other in a first direction. The second set includes two second press-fit portions which protrude oppositely to each other in a second direction perpendicular to the first direction. The first press-fit portions and the second press-fit portions are press-fit in the housing.

According to one aspect of the present invention, since each of the contacts is provided with the first press-fit portions and the second press-fit portions, the relative relation between the housing and the contact is prevented from being broken even under a case where various stresses directed in various directions are applied to the contact in a plane defined by the first direction and the second direction.

An appreciation of the objectives of the present invention and a more complete understanding of its structure may be had by studying the following description of the preferred embodiment and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing a connector and a mating connector according to an embodiment of the present invention, wherein the connector and the mating connector are in an unmated state.

FIG. **2** is a perspective view showing the connector and the mating connector of FIG. **1**, wherein the connector and the mating connector are in a mated state.

FIG. **3** is a perspective view showing the mating connector of FIG. **1**.

FIG. **4** is an exploded, perspective view showing the connector of FIG. **1**.

FIG. **5** is a partially cut-away, perspective view showing the connector and the mating connector of FIG. **1**.

FIG. **6** is a cross-sectional view showing the connector of FIG. **1**.

FIG. **7** is a front, perspective view showing a contact included in the connector of FIG. **1**.

FIG. **8** is a rear, perspective view showing the contact of FIG. **7**.

FIG. **9** is a perspective view showing a contact according to a modification.

FIG. **10** is a front view showing the contact of FIG. **9**.

FIG. **11** is a side view showing the contact of FIG. **9**.

FIG. **12** is a cross-sectional view showing a first connector and a second connector of Patent Document 1.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in FIGS. **1**, **2** and **5**, a connector **100** according to an embodiment of the present invention has so-called floating structure. The connector **100** is mateable with a mating connector **700** along the Z-direction (a mating direction or an up-down direction).

As shown in FIGS. **1** to **3**, the mating connector **700** comprises a mating housing **710** made of an insulator, a plurality of mating contacts **720** each made of a conductor and two mating holddowns **730** each made of a metal.

The mating contacts **720** are held by the mating housing **710**. The mating contacts **720** are grouped into two groups. The mating contacts **720** of each group are arranged in one row along the Y-direction (second direction) perpendicular to the Z-direction. In other words, the mating contacts **720** are arranged in two rows. The rows of the mating contacts **720** are arranged to be symmetrical to each other with respect to an axis that passes through middle of the two rows in the X-direction and extends in the Z-direction. In other words, the mating contacts **720** of one of the rows have the respective shapes which can be obtained by rotating the mating contacts **720** of a remaining one of the rows by 180° around the axis extending in the Z-direction. The mating holddowns **730** are

attached to the positive Z-side of the mating housing **710** to be located in the vicinities of opposite ends of the mating housing **710**, respectively. When the mating connector **700** is mounted on a mating circuit board (not shown), the mating holddowns **730** are fixed to the mating circuit board (not shown) by using solder.

As shown in FIGS. **1**, **4** and **6**, the connector **100** comprises a stationary housing **200** made of an insulator, a movable housing **300** made of an insulator, a plurality of contacts **400** each made of a conductor and two holddowns **500** each made of a metal.

As can be seen from FIGS. **4** and **6**, the stationary housing **200** has two alignment portions **210** and two receive portions **220**. Each of the alignment portions **210** extends in the Y-direction. Each of the alignment portions **210** is formed with a plurality of ditches each of which extends in the X-direction (first direction) perpendicular to both the Z-direction and the Y-direction. Those ditches are arranged in the Y-direction to be in parallel with one another. The receive portions **220** are formed in the vicinities of opposite ends of the stationary housing **200** in the Y-direction, respectively, to be recessed in the negative Z-direction (downward).

As can be seen from FIGS. **4** and **6**, the movable housing (housing) **300** has a plurality of holders **310** and two supported portions **320**. As described later, the holders **310** are portions for holding the contacts **400**, respectively. The holders **310** are grouped into two groups. The holders **310** of each group are provided to be arranged in the Y-direction. The supported portions **320** are provided in the vicinities of opposite ends of the movable housing **300** in the Y-direction, respectively. The supported portions **320** project in the negative Z-direction (downward) while extending outward in the Y-direction. The supported portions **320** are received in the receive portions **220** with margins, respectively, to be supported by the stationary housing **200** to be movable in the XY-plane (horizontal plane).

Referring to FIG. **4**, the contacts **400** are arranged in two rows, namely, the positive X-side contact row and the negative X-side contact row. Each of the contact rows extends in the Y-direction. Referring to FIGS. **4** and **7**, the contact **400** illustrated in FIG. **7** is included in the positive X-side contact row. The contact **400** included in the negative X-side contact row in FIG. **4**, or the negative X-side contact **400**, is different from the contact **400** shown in FIGS. **7** and **8**, or the positive X-side contact **400**, only in arrangement while having the same structure as the positive X-side contact **400**. In detail, the negative X-side contact **400** can be obtained by rotating the positive X-side contact **400** by 180° around an axis extending in the Z-direction. In other words, the negative X-side contact **400** has a shape which is point symmetrical to that of the positive X-side contact **400** with respect to a point on the XY-plane. Accordingly, hereafter, explanation is made only about the positive X-side contact **400**.

As shown in FIGS. **7** and **8**, the contact **400** has a held portion **410**, two contact support springs **460**, two contact portions **450**, a housing support spring **470** and a fixed portion **480**. The held portion **410** is held by the holder **310** of the movable housing **300** (see FIG. **6**). Each of the contact support springs **460** extends in the positive Z-direction (upward) from the held portion **410** to be resiliently deformable in the XZ-plane. The contact portions **450** are brought into contact with the mating contact **720** (see FIG. **5**) when the connector **100** is mated with the mating connector **700** (see FIG. **5**). The contact portions **450** are formed on the contact support springs **460**, respectively, to be movable in the XZ-plane. The contact portions **450** face each other in the X-direction. The housing support spring **470** has an N-like shape to be resiliently deformable. The housing support spring **470** extends from the fixed portion **480** to couple the negative Z-side (lower side) of the held portion **410** and the fixed portion **480** with each other. As can be seen from the aforementioned structure, the held portion **410** according to the present embodiment is located between the housing support spring **470** and the contact support springs **460**. In other words, the held portion **410** is located between two types of springs. The fixed portion **480** is fixed to a circuit board **600** by using solder when the connector **100** is mounted on and fixed to the circuit board **600**. The fixed portion **480** is formed with a protrusion **482** protruding in the positive Y-direction. The protrusion **482** of the fixed portion **480** is received into the ditch of the alignment portion **210** so that a movement of the fixed portion **480** in the Y-direction is regulated. In other words, the contact **400** is partially held by the stationary housing **200**. As can be seen from FIG. **6**, the held portions **410** are movable together with the movable housing **300**. In detail, when the movable housing **300** is moved in the XY-plane under a state where the fixed portions **480** are fixed to the circuit board **600**, the housing support springs **470** are resiliently deformed so that the held portions **410** are moved together with the movable housing **300**.

As can be seen from FIGS. **7** and **8**, the held portion **410** according to the present embodiment has a first planar portion **420**, two first sets each including two first press-fit portions **422**, two second planar portions **430**, two second sets each including two second press-fit portions **432**, and two coupling portions **440**. The first planar portion **420** is perpendicular to the Y-direction and in parallel with the XZ-plane. The two first sets are arranged along the Z-direction, or arranged vertically. In detail, a pair of the first press-fit portions **422** located at the positive Z-side (upper side) constitute one of the first sets while another pair of the first press-fit portions **422** located at the negative Z-side (lower side) constitute a remaining one of the first sets.

The two first press-fit portions **422** included in each of the first sets protrude oppositely to each other in the X-direction from the first planar portion **420**. Each of the first press-fit portions **422** according to the present embodiment is a so-called press-fit protrusion (also called barb or wedge) which is formed to protrude. More specifically, the first press-fit portion **422** according to the present embodiment has an arrow feather shape with an angular portion of a right angle or an acute angle. In the present embodiment, a protruding amount of the first press-fit portion **422** located at the negative Z-side (lower side) is more than another protruding amount of the first press-fit portion **422** located at the positive Z-side (upper side). Each of the second planar portions **430** is coupled with the first planar portion **420** by the corresponding coupling portion **440**. Each of the second planar portions **430** is perpendicular to the X-direction and in parallel with the YZ-plane. In other words, the coupling portion **440** couples the first planar portion **420** and the second planar portion **430** with each other so that the first planar portion **420** and the second planar portion **430** are perpendicular to each other. The coupling portion **440** not only prevents a stress applied to the first planar portion **420** from being transmitted to the second planar portion **430** but also prevents another stress applied to the second planar portion **430** from being transmitted to the first planar portion **420**. The second sets are formed on the second planar portions **430**, respectively. In other words, each of the second planar portions **430** is formed with a pair of the second press-fit portions **432** which constitute the second set. From another point of view, the second set is formed on the contact support spring **460**. In other words, each of the contact support springs **460** is provided with the

contact portion **450** and one or more of the second sets. The two second press-fit portions **432** included in each of the second sets protrude oppositely to each other in the Y-direction from the corresponding second planar portion **430**. Each of the second press-fit portions **432** according to the present embodiment is also a so-called press-fit protrusion (also called barb or wedge). As can be seen from FIGS. **6** and **7**, the first press-fit portions **422** and the second press-fit portions **432** of the held portion **410** are press-fit in the holder **310** of the movable housing **300**. Accordingly, the first press-fit portions **422** and the second press-fit portions **432** are held by the movable housing **300**.

As previously described, the held portion **410** according to the present embodiment is located between the two types of springs, namely, the contact support springs **460** and the housing support spring **470**, to receives various forces directed in various directions. However, since the held portion **410** has the first press-fit portions **422** protruding oppositely to each other in the X-direction and the second press-fit portions **432** protruding oppositely to each other in the Y-direction, the held portion **410** is kept to be securely held by the holder **310**. Accordingly, the held portion **410** is prevented from being loosely held by the holder **310** and is prevented from coming off the holder **310**.

Although the held portion **410** according to the aforementioned embodiment has the two first sets each of which includes the two first press-fit portions **422**, the present invention is not limited thereto. For example, the held portion **410** may have only one of the first sets. Moreover, although the held portion **410** has the only one second set, which includes the two second press-fit portions **432**, in each of the second planar portions **430**, the present invention is not limited thereto. For example, each of the second planar portions **430** may be provided with two or more of the second sets. In other words, the contact **400** may have one or more first sets and one or more second sets.

Although the first planar portion **420** and the second planar portion **430** according to the aforementioned embodiment are coupled with each other by the coupling portion **440** to be perpendicular to each other, the present invention is not limited thereto. For example, the first planar portion **420** and the second planar portion **430** may be provided to be in parallel with each other. In this case, the coupling portion **440** may be omitted. Moreover, in this case, the first press-fit portions **422** or the second press-fit portions **432** may be formed of, for example, protrusions. Alternatively, the first planar portion **420** may be partially cut and bent in a direction intersecting the first planar portion **420** in order to form the first press-fit portions **422**. Similarly, the second planar portion **430** may be partially cut and bent in a direction intersecting the second planar portion **430** in order to form the second press-fit portions **432**.

Although each of the first press-fit portions **422** and the second press-fit portions **432** according to the aforementioned embodiment is the press-fit protrusion, the present invention is not limited thereto. For example, each of the first press-fit portions **422** and the second press-fit portions **432** may be formed of an embossed protrusion. However, because the press-fit protrusion securely bites the housing (movable housing) **300** in comparison with the embossed protrusion, the held portion **410** provided with the press-fit protrusions is more securely held by the holder **310**.

Although the contact **400** according to the aforementioned embodiment has the two contact support springs **460** each provided with the contact portion **450**, the present invention is not limited thereto. For example, the contact **400** may have only one of the contact support springs **460** (see structure of a contact **400**A shown in FIG. **9**).

Although the connector **100** according to the aforementioned embodiment has the so-called floating structure, the present invention is not limited thereto. The concept about the held portion **410** according to the present embodiment is also applicable to a contact of a connector which does not have floating structure.

Hereafter, as referring to FIGS. **9** to **11**, explanation is made about the contact **400**A of a connector (not shown) which does not have floating structure. The contact **400**A is a modification of the contact **400** (see FIGS. **7** and **8**) according to the present embodiment. As shown in FIGS. **9** to **11**, the contact **400**A has a held portion **410**A, a contact support spring **460**A extending from the held portion **410**A, a contact portion **450**A supported by the contact support spring **460**A and a fixed portion **480**A extending from the held portion **410**A. The held portion **410**A is located between the fixed portion **480**A and the contact support spring **460**A.

The held portion **410**A has a first planar portion **420**A, two first sets each including two first press-fit portions **422**A, a second planar portion **430**A, a second set including two second press-fit portions **432**A, and a coupling portion **440**A. The held portion **410**A is provided with the single first planar portion **420**A and the single second planar portion **430**A. The first planar portion **420**A and the second planar portion **430**A is perpendicular to each other. The two first press-fit portions **422**A of each of the first sets protrude oppositely to each other from the first planar portion **420**A. The two second press-fit portions **432**A of the second set protrude oppositely to each other from the second planar portion **430**A. The protruding direction of the first press-fit portions **422**A is perpendicular to the protruding direction of the second press-fit portions **432**A. Accordingly, when the contact **400**A with this structure is press-fit into a housing (not shown), the housing does not loosely hold the contact **400**A even if various stresses along various directions are applied to the contact **400**A. Moreover, because a stress applied to the housing is hardly transmitted to the fixed portion **480**A even under a state where the fixed portion **480**A is fixed to a circuit board (not shown) by using solder, the solder is prevented from being cracked.

In the aforementioned embodiments, the two press-fit protrusions included in the first set, namely, the two first press-fit portions **422** or the two first press-fit portions **422**A, have the same shape as each other. Similarly, the two press-fit protrusions included in the second set, namely, the two second press-fit portions **432** or the two second press-fit portions **432**A, have the same shape as each other. However, the present invention is not limited thereto. The two press-fit protrusions included in the first set may have different shapes from each other. Similarly, the two press-fit protrusions included in the second set may have different shapes from each other. In other words, the press-fit protrusions that constitute a pair may have different shapes from each other.

The present application is based on a Japanese patent application of JP2013-164567 filed before the Japan Patent Office on Aug. 7, 2013, the contents of which are incorporated herein by reference.

While there has been described what is believed to be the preferred embodiment of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such embodiments that fall within the true scope of the invention.

What is claimed is:

1. A connector comprising a stationary housing, a movable housing and a plurality of contacts, wherein:

each of the contacts has one or more first sets and one or more second sets;

the first set includes two first press-fit portions which protrude oppositely to each other in a first direction;

the second set includes two second press-fit portions which protrude oppositely to each other in a second direction perpendicular to the first direction;

the first press-fit portions and the second press-fit portions are press-fit in the housing;

the connector is to be mounted on a circuit board;

the movable housing is movable relative to the stationary housing;

the first press-fit portions and the second press-fit portions are held by the movable housing;

each of the contacts has a fixed portion and a housing support spring partially held by the stationary housing;

the housing support spring extends from the fixed portion; and

the fixed portion is fixed to the circuit board when the connector is mounted on the circuit board.

2. The connector as recited in claim **1**, wherein each of the first press-fit portions and the second press-fit portions is a press-fit protrusion.

3. The connector as recited in claim **1**, wherein:

each of the contacts has a first planar portion, a second planar portion and a coupling portion;

the first planar portion is perpendicular to the second direction;

the second planar portion is perpendicular to the first direction;

the coupling portion couples the first planar portion and the second planar portion with each other;

the first press-fit portion protrudes from the first planar portion in the first direction; and

the second press-fit portion protrudes from the second planar portion in the second direction.

4. The connector as recited in claim **1**, wherein:

each of the contacts has two contact support springs;

each of the two contact support springs is provided with a respective contact portion and with one or more of the second sets; and

the contact portions face each other in the first direction.

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